

ADVANCES IN THE PROCESSING OF POTATOES INTO STABLE FORMS — A REVIEW

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Introduction

THE PER capita consumption of potatoes in the United States has steadily declined from an average of 176 pounds during the 1909-1915 period to 101 pounds in 1952. This reduction of 75 pounds is roughly equivalent to an annual loss of market for about 200 million bushels of potatoes based on our present population. This drastic decline in per capita consumption has been due to a number of causes, one of which is undoubtedly the inconvenience of preparing fresh potatoes for table use. Other factors include changes in dietary habits and the availability of an increasing variety of other foods (1).

POTATOES

PRODUCTION, CONSUMPTION AND SURPLUS

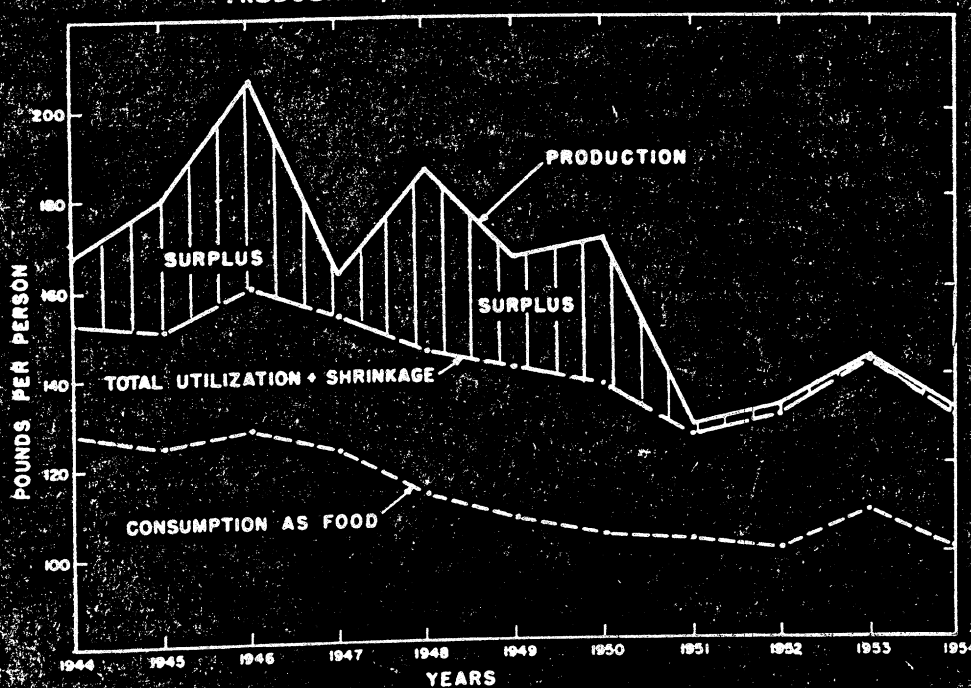


FIGURE 1

The decrease in consumption of potatoes is partly responsible for the substantial surpluses that accumulated in the United States from 1944 to 1950. As is shown in Figure 1, the surpluses from 1951 to 1954 were much smaller. The 1954 crop of 351 million bushels was, in fact, approximately in balance with the total requirement. Figure 2 shows how this crop was utilized, according to the estimates of the Agricultural Marketing Service of the U. S. Department of Agriculture. These figures indicate that the

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total food use of potatoes during that year amounted to approximately 79 per cent of the total crop.

In 1955, 381 million bushels of potatoes were produced. This was 42 million bushels in excess of the production goal, but the surplus was diverted to starch and feed so that the amount for total utilization plus shrinkage (weight loss and spoilage during storage) was near the figure for total production.

Anticipating another surplus in the fall of 1956, the U.S. Department of Agriculture again set up the mechanism for a diversion program designed to bring total utilization into eventual balance with the year's production (2). On December 1 the 1956 crop of potatoes were estimated at 243,238,000 hundredweights or about 405 million bushels.

Processing Potatoes for Food

Figure 3 shows a gradual increase in the quantities of potatoes processed into food from 1948 to 1954. It is estimated that about 54 million bushels of the 1955 crop was used in food processing. Preliminary estimates (1) indicate that about 60 or more million bushels will be used for the purpose in 1956 which is about one-half greater than the amount processed for food in 1954.

UTILIZATION OF 1954 POTATO CROP 351 MILLION BUSHEL

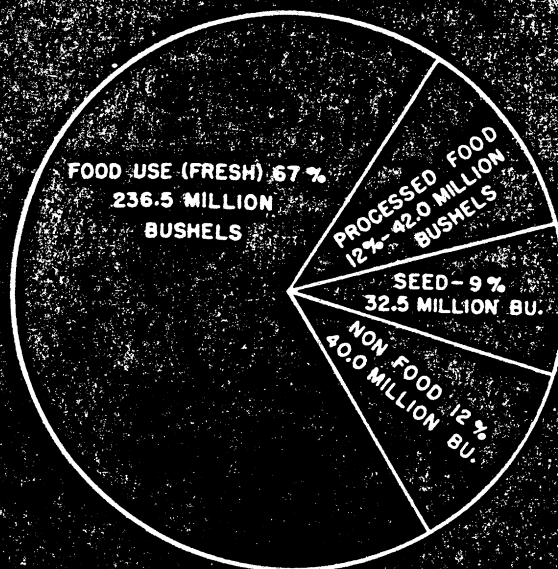


FIGURE 2

Processing of potatoes is expected to increase. Whether or not this will do much more than maintain the present total per capita consumption is open to question. However, a continuous rise in population should ensure an increasing demand for potatoes and thus an expanding future market for growers.

Of great significance to the growers is the amply demonstrated fact that extensive processing of a perishable commodity tends to stabilize farm prices by the tendency to balance periodic gluts and shortages against the relatively constant consumer demand.

It also makes possible the development of distant and foreign markets to which it would be impractical to ship fresh produce.

The modern supermarket now carries many processed food products prepared from potatoes. These products include potato chips, dehydrated mashed potatoes, canned whole and shoestring potatoes, and potato soup. Also available in frozen form are French fries, patties, puffs, hash brown, dice, whipped and baked potatoes, and potato soup. Dehydrated potato dice are manufactured primarily for use in canned hashes and stews. Potato chips have long been a familiar and popular item but most of the others, particularly the frozen products, have made their appearance within the past ten years.

Potato Chips

More potatoes are used in the manufacture of potato chips than in all other processed potato food products combined. During the period 1946 to 1955 the quantity of potatoes used to make chips increased from 15.4 to about 40 million bushels. Potato chips have high food value and are appealing in flavor, texture and color.

Color control is the most important single problem in chip manufacture. High content of reducing sugars, which react with the nonprotein nitrogen compounds, is believed to be the principal cause of excessive browning during frying. Reducing sugar content increases during cold storage and is usually lowered by reconditioning the tubers for several days to a few weeks at about 70° F. Better color control is an important objective of potato chip research supported by the U.S. Department of Agriculture. Much of the research conducted by the Federal Government and by State Experiment Stations is concerned with the relaxation of variety, cultural history, storage conditions, composition, and physical properties of potatoes to the quality of chips made from them. A survey, the results of which were recently announced by Dr. Ora Smith of Cornell University, shows that more than 450 research projects in 35 states and 9 Canadian provinces are related to potato chips.

Next to the prime requirement that potatoes for chip manufacture have low re-

RIISING USE OF POTATOES AS PROCESSED FOODS

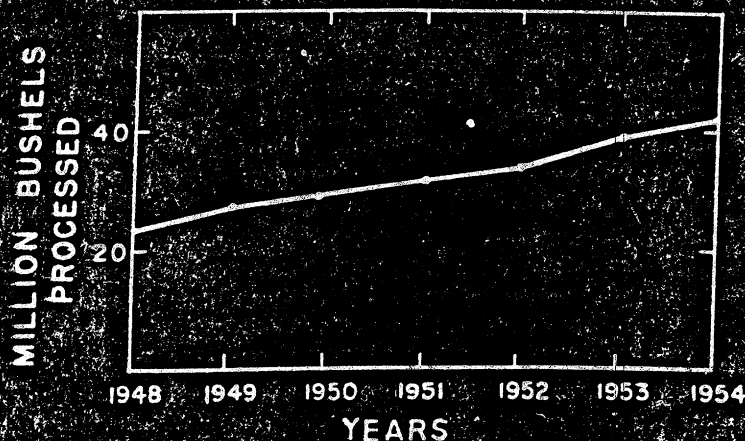


FIGURE 3

ducing sugar content, high total solids content (high specific gravity) is also desirable. Chippers prefer such potatoes because they give a better yield of chips and absorb less fat during frying.

Several experimental products have been developed recently by the Eastern and Western Regional Research Laboratories that either use chips or are prepared by methods similar to those of chip making. These include potato chip bars (4), crushed chip candy products, potato "chiplets", and potato "nuts". Chip bars are prepared by compressing crushed chips into self-supporting pieces. "Chiplets" are made from potato strips about $3/32'' \times 1/2'' \times 1/2''$ that are dried and then partially reconstituted in water before frying. Potato "nuts" are made by frying dice about $1/4''$ on a side in deep fat. None of the products is made commercially at present but potato chip bars are in standby status as a possible ration for the armed forces.

Frozen Potato Products (2) (3)

French fries are by far the most important potato product that is frozen. Total production of frozen potato products reached 183 million pounds in 1955 according to an Agricultural Marketing Service survey. Frozen French fries became a commercial product shortly after the close of World War II. The demand for frozen French fries has regularly increased, and an estimated 4.2 million bushels of potatoes were used for their production in 1955.

The requirements in raw material for French fries are about the same as for chips. In addition to color control, however, texture is also a problem with frozen French fries. Slices that are soft and soggy at the centre after the finish heating or frying are undesirable. Soft centres of slices are thought to be associated with low total solids content more than with any other single factor. Although frozen French fried potatoes are still not uniformly of as high quality as processors would like, they are increasingly popular because of the convenience they offer.

In the processing of French fries, clean, peeled potatoes are sliced into strips of $3/8$ or $1/2$ -inch square cross section. The slices are washed to remove starch. Frying in the processing plant is often done in two stages. This permits separation of slices that stick together during the first fry. Some processors, however, fry in a single step and depend on turbulence in the bath or on stirring or tumbling to keep the slices from sticking together.

Frying temperatures and times differ from plant to plant and with different raw material. In addition to reduction of frying temperatures when necessary, color is also controlled by a one-to-two minute hot water blanching before frying. In some processing plants all raw material is water blanched and, where necessary, a subsequent dip in glucose solution is carried out to obtain the desired degree of browning. Some processors freeze French fries before packaging and others after. A large fraction of the French fries produced are sold for household use. Housewives prepare the product for the table by warming in the oven. Restaurants prepare the frozen product by frying for one or two minutes at 375° F.

Frozen fried potato puffs and frozen whipped potatoes are usually made from the small pieces sorted out in the processing of French fry slices. The slivers are steamed and mashed. For whipped potatoes, the mash is vigorously beaten before freezing. For producing puffs the mash is mixed with wheat flour, eggs and seasoning. This mixture is formed into croquettes and fried before freezing.

Frozen diced potatoes for hash browning have been on the market several years. The potatoes are sliced into cubes about $3/8''$ on a side, steam blanched and then frozen. Onion flavouring is sometimes added before freezing to complete the processing. This product is cooked by frying in a skillet.

Frozen potato patties have been on the market for about three years. Peeled potatoes are blanched, cooled, shredded, mixed with flour and shortening, and then shaped into circular or rectangular pancakes before freezing. These patties, weighing about 3 ounces each, may be fried in deep fat or in a pan.

Canned frozen cream of potato soup appeared in the retail markets within the past three years. This soup contains small pieces of potatoes as well as mashed potatoes. It has been well received by consumers because the flavour is superior to that of ordinary canned potato soup.

Dehydrated Potato Products

Dice are produced in larger quantities than any other dehydrated product. Their principal outlet is in canned products such as hashes and stews. Some packers use dice in preference to fresh potatoes. To manufacture dice (1), the potatoes are peeled, trimmed and cut into $\frac{3}{8}$ -inch or smaller sized cubes, as well as so-called half dice and other rectangular shaped pieces. The dice are then blanched and dehydrated.

Potato flour has grown slowly in demand since its introduction shortly after World War I. It is used by some bakeries in making bread to the extent of about two or three per cent of the weight of wheat flour used. It is also used in prepared doughnut mixes, and in specialty items.

Potato flour is made from whole potatoes which are peeled, cooked, mashed and dried on a special type of drum drier equipped with 4 or 5 auxiliary rolls that spread the mashed potatoes over the drum surface. The dried potato is ground into either a coarse or fine flour to satisfy customer preference.

Dehydrated mashed potatoes are rapidly gaining in demand in both retail and the institutional trade. There are two types of this product presently produced which are commonly known as "Instant" and as "Minute" mashed potatoes. A third form called "Potato Flakes" has been recently developed at the Eastern Regional Research Laboratory and is expected to be commercially available in the near future. This product will be discussed in more detail later.

"Instant" mashed potatoes (5) is a fine granular product also known as potato granules. "Minute" potatoes consist of short, hollow cylinders of about $\frac{3}{8}$ inch in diameter having thin, porous walls. At present "minute" potatoes are produced in much smaller volume than the granules. During the 1955-1956 processing season about 20 million pounds of dried mashed potatoes were produced from about 2 million bushels of potatoes (1). It is predicted by processors that production of potato granules will be greatly increased during the 1956-1957 season.

Potato granules, "minute" potatoes, and flakes can be quickly converted to mashed potatoes by mixing with hot water or hot milk or both. Flakes can be reconstituted even in cold water. Ease of preparation and good quality make these products highly promising household items that fit in well with the growing demand for "convenience" foods. These products are considered advantageous, too, for the restaurant operator because individual or small batches of servings can be prepared quickly on short order, thereby avoiding the loss of quality ordinarily associated with prolonged holding of mashed potatoes on a steam table.

Substantial impetus to the commercial production of potato granules has been provided by the improvement of processing techniques, the development of new drying machinery, and the establishment of better quality control and packaging conditions which are essential to long shelf life. Significant contributions to these advances have been made through the research of the Department of Agriculture's Western Utilization Research Branch (6), the University of North Dakota, the Quartermaster Food and Container Institute (7) and private industry.

Potato Flakes

Potato flakes (8) are a new form of dehydrated mashed potatoes developed at the Eastern Regional Research Laboratory. They can be rehydrated with milk and water over a wide temperature range to produce mashed potatoes having excellent flavour, colour and texture. These attributes can be easily controlled in the flake process because the potatoes are ready for drying immediately after mashing, and the dehydration is accomplished in less than a half minute after application of mashed potato to the drier drum. Therefore, the development of off-flavours, due to long holding periods or prolonged heating during dehydration, is minimized.

The Process. A flow diagram of the potato flake process is shown in Figure 4. The preferred process (9) consists of the following operations. The potatoes are peeled, preferably by the low temperature lye process, then trimmed and sliced into $\frac{3}{8}$ -inch slabs, washed to remove free starch, and pre-cooked.

The most important single factor controlling mealiness is this recently developed precooking step, in which the potato is heated to a temperature in the range of about

FLOW DIAGRAM OF POTATO FLAKE PROCESS

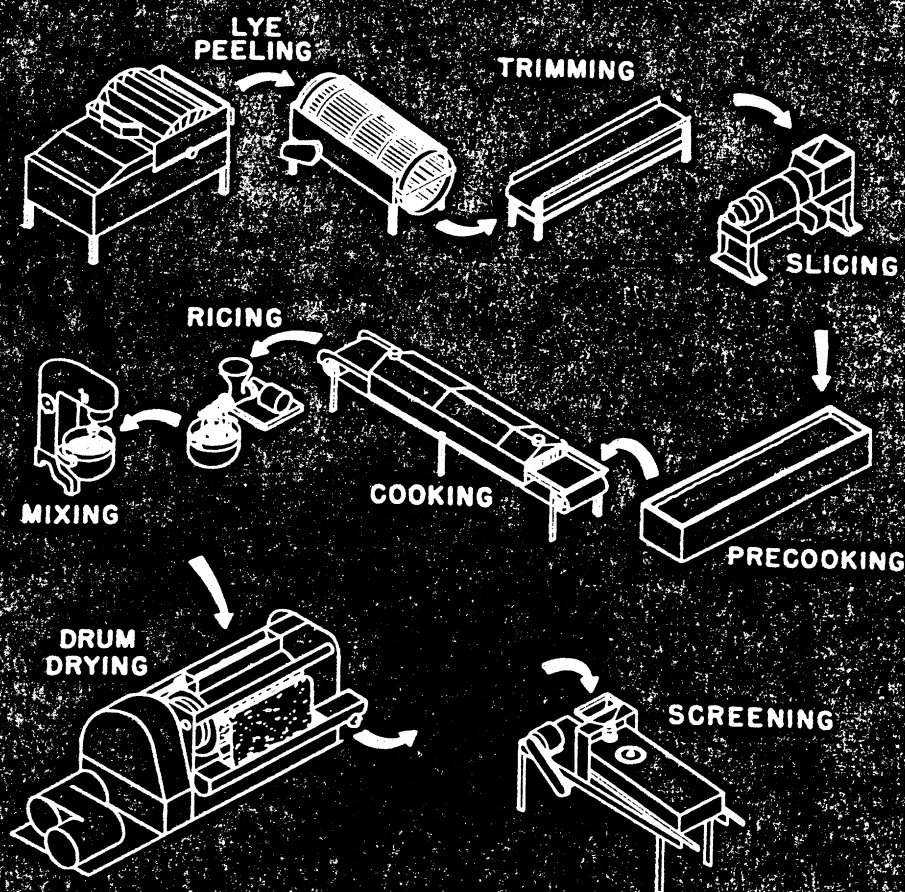


FIGURE 4

140 to 180° F. for a suitable time, usually about 20 minutes (10), prior to final cooking at 212° F. Through the use of the precooking step it is now possible to make a mealier product not only from high-solids-content potatoes, which are usually used in dehydration processes, but also from lower-solids-content potatoes not suitable heretofore.

After precooking, the potatoes are cooked in steam at atmospheric pressure for about 18 to 22 minutes depending upon the variety and solids content of the potato. They are then riced and mixed with a small amount of antioxidant and sulfite solution to help prevent deterioration when stored. A single drum drier of the type commonly used to make potato flour is employed to dry the mash. Another recent development is the use of a device attached to the drier to break the dried potato sheet into 3/4-inch squares.

One of the advantages of the flake process is that the product can be dried directly to 4.0 to 4.5 per cent moisture in one operation in less than a minute. Off-flavours arising from nonenzymatic browning during storage are retarded in this moisture range. Hence, for good keeping properties the package should include an effective moisture barrier.

Market Acceptance Test. The integrated single-drum drier pilot plant installed at the Eastern Regional Research Laboratory was used to convert a carload of Russet Burbank potatoes grown in Maine into flakes for a market acceptance test. About 4,700 pounds of flakes were made in about 16 days of operation. The simplicity of the process and its commercial feasibility were demonstrated by the fact that no changes in operating procedure were required during the run. The run yielded about 23,000 packages of 4 servings each which were test-marketed in 40 stores in the Binghamton-Johnson City-Endicott area of New York State. This test was made by the Agricultural Marketing Service in cooperation with the Agricultural Research Service, the Maine Potato Commission and several other State of Maine agencies.

A preliminary report showed that a total of 894 cases of potato flakes, each case containing 24 4-serving boxes, were sold during the 5-week market test period. This was virtually the whole supply available. It represents purchases of about 14 per cent of the households in the area. A door-to-door canvass made after the sale period showed that 60 per cent of the flake purchasers had bought the product two or more times, and that 90 per cent of them would buy it again in the future if it were available. The test showed that even though the price of fresh potatoes rose during the course of the market survey, fresh potato sales were not reduced by the introduction of flakes. Excluding potato chips and frozen fries, the sales of potato flakes were far greater than the combined sales of all other potato processed foods.

As a result of the consumer acceptance test and because of the excellence of the product and the simplicity of its manufacture, at least four companies and groups have indicated their intention to manufacture potato flakes.

Summary and Conclusions

The per capita consumption of potatoes in the United States was 75 pounds less in 1952 than was the average consumption for the period 1909-1915. Based on the present population, this represents a loss of about 200 million bushels. The increase in use of processed potato foods in recent years seems to have stopped the decline in consumption. It is estimated that 54 million bushels of potatoes were processed for food use in 1955. The future of the potato industry definitely depends on the development of new and improved processed foods as well as on the ability of the industry to provide the consumer with a high-quality fresh product. The potato grower should take cog-

nizance of this fact and strive to produce potatoes that are well suited for processing and fresh use.

More potatoes by far are used in making chips than in any other processed potato food. More new products have been commercialized in the frozen field than in any other category of processed potatoes. Dehydrated and canned potatoes continue to absorb significant quantities of raw material.

Research on new and improved forms of dehydrated mashed potatoes has received major attention in recent years. Improvements have been effected in the manufacture of granules (mashed potato powder) and also in their quality. Potato flakes is a new type of dehydrated mashed potato product that soon is expected to be manufactured commercially. The increase in demand for potatoes in processed foods seems to have stemmed the decline in potato consumption and it may not be wishful thinking to believe that this demand may soon result in an actual increase in the per capita consumption of potatoes.

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